EXTENDED REFRESHABLE TACTILE GRAPHIC ARRAY FOR SCANNED TACTILE DISPLAY

RELATED U.S. PROVISIONAL PATENT APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application No. 60/346,152, filed Jan. 3, 2002, this application including portions of the written description pertaining to certain ones of the inventions described therein and making claim to those inventions.

FIELD OF THE INVENTION

This invention relates to graphic display apparatus and methods, and, more particularly, relates to such apparatus and methods that provide extended, refreshable graphic display.

BACKGROUND OF THE INVENTION

Many approaches for provision of tactile graphics are currently known and/or utilized. For example, tactile graphic embossers are commercially available, for example the Tiger Embosser by ViewPlusTech Corporation. Embossers provide permanent printout on consumable material such as paper or plastic, but do not provide refreshable display capability.

Approaches for providing refreshable arrays of tactile graphics (i.e., graphics that remain statically positioned as a user senses them, for example by movement of the hand in contact with the graphic display, but are able to be changed at the array surface after the user has sensed them) have also been heretofore suggested and/or utilized. One example is a Braille display using microvalves that direct air to inflate what are essentially small elastic balloons in a fixed matrix to form the Braille dots (by Orbital Research). The balloons in the matrix are placed in a pattern consistent with the dimensions of Standard Braille, the goal being to create an extended display with sufficient resolution to display Braille text which remains static as the user reads it. Since the balloons are part of the reading surface, they are well suited to Braille text. The reading surface has spaces between the dots where the balloons can be anchored, which may be less effective in a tightly spaced rectangular array. Continual application of power is required to keep the balloons inflated and the Braille text displayed (see U.S. Pat. No. 6,105,904 and http://www.orbitalresearch.com).

In another example, NASA Jet Propulsion Laboratory has specified a tactile display using an electroactive silicone polymer that contracts when subjected to an electric field. Cells of this polymer are attached to a rubbery film that forms the reading surface of the display. Application of an electric field to a cell causes the corresponding section of the rubbery film to be pulled down—the stimulus pattern is thus comparable to a photographic negative of the raised pattern that is to be displayed. The display appears to be two-level (all stimulus points either up or down). An actuator (electric field application) is needed at every stimulus point (i.e., cell). Continued application of electrical stimulus would be needed to maintain the displayed image (see Yoseph Bar-Cohen of Caltech, Technical Support Package NPO-20410, at http://www.nasatech.com/Briefs/Feb01/NP020410.html). Other approaches are known and have heretofore been utilized, including, for example, selectively magnetically

active reading surfaces for setting and retaining code units (such as magnetized balls—see U.S. Pat. No. 4,551,102).

Extended tactile graphic arrays (a relatively large array of many movable units, such as pins, that create a textured surface that a user reads by moving the fingers over the surface) have significant advantages for certain specific applications compared to arrays smaller in scope. Since such an array is displacement-based, it creates a real tactile object which the user scans by finger motion (and thus dimensional accuracy must be maintained), which is the method most users are accustomed to. It allows use of arbitrary numbers of fingers on both hands (as well as the palms of the hands), does not require motion of the pins during the reading process (thus the possibility of low power consumption and the certainty of the geometric stability of the image being read), and can be implemented with lower density and less complex pin structures than those typically needed by the smaller displays. It is therefore desirable to find technology to make an extended refreshable tactile graphic array economically feasible, since cost has been the main impediment to implementation and to the development of commercial products.

While smaller scanned tactile graphic displays have many applications (see U.S. Pat. Nos. 2,521,338, 5,195,894 and 6,109,922 for examples), an extended tactile graphic array is likely to be used mainly for accessibility applications for blind and visually impaired users. Such arrays should therefore be optimized for accessibility uses, the simplest of which are line drawings, two-dimensional drawings with patterns/textures to differentiate objects being displayed, and Braille.

Refreshable tactile graphic displays based upon an extended tactile graphic array have heretofore consisted of a relatively large flat surface, with an embedded array of movable components (often movable pins are utilized) that can be moved in and out to form a pattern that the user senses by moving the fingers laterally across the surface. For best usability, the pin density must be high enough to permit the user to correctly interpret the depiction of edges and lines—an example might be ten to twenty pins per linear inch. The overall display surface must also be large enough to permit the depiction of reasonably complex graphic images. As a consequence of these two requirements, a usable extended tactile graphic array should have thousands to tens of thousands of movable components (pins).

Conventional approaches to implementation of such a pin array call for a corresponding array of thousands to tens of thousands of piezoelectric or other actuators, one per pin. The inherent cost of such a large number of small actuators and the cost of the power and control systems to operate them have made such a display extremely expensive (current actuators of this type cost at least several dollars each). In order to reduce cost, it is necessary to develop a technology that does not require a separate powered actuator for every pin. As evidenced by the foregoing, it will be appreciated that further improvement in the field of extended tactile graphic array for graphic display is needed.

SUMMARY OF THE INVENTION

This invention provides apparatus and methods for extended, refreshable display of graphics, and particularly provides an extended refreshable tactile graphic array for scanned tactile displays that accommodates both a Braille matrix and a closely spaced matrix for graphics, that does not require the application of power to maintain the displayed image once the stimulus points, or pins, have been